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UWIST Paper 4

Invertebrates: River Wye

Introduction

Except for a single summer survey by Morgan (1970) no significant investigations of the invertebrate fauna of the R. Wye have been undertaken as far as we are aware. The current programme was designed to describe the distribution and relative abundance of aquatic invertebrates, in the R. Wye and those tributaries relevant to the proposals to regulate discharge in the river system. In addition, a more intensive localised study has been established to describe the population dynamics of selected invertebrate communities more precisely and to establish the feasibility of assessing the effect of secondary production of regulating discharges. Complementary studies on the drift of invertebrates have been undertaken. These data will be needed as a basis for evaluating the effects of the proposed Craig Goch scheme on the invertebrate fauna in the Wye catchment.

Methods and Sampling Sites

All benthic samples were collected from riffles using a cylinder sampler (UWIST, 1976c). Temperature, depth and current velocity were recorded at each visit.

The qualitative study of benthic invertebrates took the form of a general survey at sites (Fig. 1, Table 1) along the length of the river, discharge permitting. Sampling was undertaken in March and September 1975: at each site four cylinder samples (net aperture, 400µ) were collected across the width of a riffle.

At two sites, W2 and W3, benthic samples were taken more frequently during the year, as often as weekly during summer months. The number of replicate samples taken at each site varied from 8 to 15. Replicate samples were located within the riffle on a stratified random basis and two detachable nets used together (400 and 150 µ aperture mesh) facilitated field separation by size. Data from monthly samples, collected with the 400µ net, are presented here.

Drifting invertebrates were collected generally every month after February with a modified plankton sampler (Elliot, 1970) of net mesh aperture 440µ at W2, W3, W4, W5 (Table 1) and also at D1 (the R. Wye at Llanwrthwl, SN 640976, 40 km from source). In addition drift was studied over a 3 day period during the experimental release of water from Caban Coch in May (UWIST 1976a). Each sampling period was at least 24h and generally the samplers were serviced at 3h intervals when measurements of water velocity, depth and temperature were also recorded. The relationship between the velocity of water measured, with a portable current meter, at the exit of the sampler and the flow through the sampler was established in an experimental flume. Average flow through the sampler between servicing intervals was calculated from velocity measurements at the beginning and end of the period assuming any changes in flow were linear with time. Drift density is expressed as no./100m^3. On one occasion when the density of planktonic organisms discharged from Caban Coch Reservoir into the R. Elan was known to be substantial, between 10 and 20 multiple 2 litre dip samples were collected at sites along the R. Elan and R. Wye and estimates of density made. Samples were concentrated in 150µ mesh sieves and organisms counted under low magnification.

The different aspects of this study are considered separately below under the headings:-

1. Benthic Invertebrate Studies: General Survey
2. Benthic Invertebrate Studies at key sites
3. Invertebrate Drift

1. <u>Benthic Invertebrate Studies: General Survey</u>

<u>Results</u>

129 taxa (mainly species) were recorded from two surveys (March and September 1975) of the R. Wye (Appendix 1). The number of such taxa collected at different sites varied from 21 to 37 in March and 19 to 53 in September (Fig. 2). Generally, the number of taxa collected increased with distance downstream and substantially more groups were collected in September than March (Fig. 2). The Chironomidae often contributed a substantial proportion of the total number of species (E.g. W1, W4, Appendix 1), ranging from 10 to 36%.

Calculation of the Jaccard Index:-

$$I = \frac{j}{a + b - j}$$

where a = number of taxa at site A
b = number of taxa at site B
and j = the number of taxa found at both sites.

and construction of dendrograms after average-linkage cluster analyses (Sneath and Sokal 1973) indicated some zonation of invertebrate taxa along the length of the river. The strongest consistent association was between W2 and W3, the two sites chosen for quantitative studies, but the relationship between other sites was less strong and varied between the two sampling periods. Nevertheless, groups of spatially associated sites clustered along the length of the river and these are more 'orderly' in September (Fig 3). W1, the upper-most site 7km from source always showed least association with the other sites.

The next two sites, W2 and W3, were loosely associated with W4 and, in September, with W5 and W6. sites W7, W8 and W9 seem fairly similar faunistically as it seems, from the September observations at an extended series of sites, are sites W0, W11, W12 and W13. there is no evidence that these faunal associations were related to water velocity or depth (Table 2).

Estimates of total invertebrate density ranged from 945 to 4765/m^2 and 635 to 15660m^2 in March and September respectively (Fig 2): the confidence limits on these estimates are shown in Table 3. Generally estimates of density in the upper reaches (W1-W5) were similar in March and September, varying between 1000 to

2000/m^2 but at stations W6-W10 September densities were generally greater than those in March varying from 2700 to 12000/m^2 (Fig. 2).

Diversity per individual (Shannon 1948) was calculated from

$H' = - \{ pi \log_2 pi$

where the proportions pi in the equation are intended to be the true proportions of the taxa from the populations being sampled. In practice these are usually estimated from the sample as pi ≈ ni/N where N is the total number of individuals comprising ni in each of s species, I = 1, 2, …….s. In this context arbitrarily designated species-groups were regarded as species.

H' varied between 2.638 and 4.869 and was generally greater in September than in March (Table 3). The low value of H' at W9 (Glasbury) in March (Table 3) resulted principally from the very uneven distribution of individuals between species at this site. Although the total density and total numbers of taxa were not significantly different from adjacent stations, one species, *Rhithrogena semicolorata*, represented 61% of the total density. Calculation of the ratio indicated that at W9 in March it was 11.3 while at all other sites in both surveys the ratio did not exceed 5.0.

Most Abundant Species

In March the Plecoptera was the most abundant group in the upper reaches (W1 – W3) but in the reaches further downstream (W5-W10) the Ephemeroptera and Oligochaeta formed the major groups. In September there was a more general co-dominance of the Oligochaeta, Plecoptera, Ephemeroptera, Trichoptera and chironomidae, their proportions varying considerably from site to site but with no clear spatial pattern. At isolated stations the Coleoptera, Simuliidae and Mollusca were numerically important.

In the upper reaches the principal plecopterans were *Amphinemura sulciocollis*, *Chloroperla* spp. and *Leuctra* spp. Only *Leuctra geniculata* was recorded at W11-W12 (Fig. 4). Of the Ephemeroptera, *Baetis rhodani, B. scambus* and *B. muticus* were distributed throughout the catchment. Ephemerella ignite *was restricted to W1-W5 and* Rhithrogena semicolorata *and Ecdyonurus dispar* were recorded from W1-W10. The distribution of the tricopteran *Hydropsyche siltalai* was restricted to W1-W8 whilst *H. contubernalis* and *Cheumatopsyche lepida* were found at W7-W13 only: *H. pellucidula* was distributed along the length of the river (Fig. 4).

The Lumbriculidae were the principal Oligochaetes although *Rhyacordrilus coccineus* (Tubificidae) increased in abundance at sites below W6 (Appendix I).

The major representatives of the Chironomidae were the Orthocladiinae and Diamesiinae, particularly in the upper and middle reaches (W1-W10). At W1 where total invertebrate density never exceeded 1000/m^2 (Fig. 2, Appendix 1) the Chironomidae, chiefly *Diamesa* spp., always formed a large component of the fauna (Table 4).

Occasionally (W1, March and W6, September) the Simuliidae formed a substantial proportion of the total fauna but at many sites, particularly in March, they were not recorded (Appendix 1).

At W4 (R. Elan) the density of *Hydropsyche* spp and coleopteran species was low in comparison to sites on the R. Wye, especially in September (Table 4, Appendix 1).

Discussion

Few studies of invertebrates in large rivers have been undertaken in the U.K. Morgan (1970) surveyed the R. Wye in June five years ago and the general distribution of the fauna down the river was similar to that reported in this study. Some specific differences are apparent: in 1970 only *Leuctra geniculata* and *L. inermis* were recorded in the 'lower reaches' whereas in 1975 *L. hippopus* and *L. moselyi* were additionally collected as far downstream as W11. Rare species collected by Morgan but not found in 1975 included *Baetis buceratus, Ephemera lineate* and *Brachycentrus harrisella*. The fauna of the upper reaches of the R. Wye recorded in this study were simiar to that recorded by other workers for upland rivers and streams (Morgan and Egglishaw 1965; Minshall and Kuehne 1969; Armitage *et al* 1974, 1975).

Truesdale (1974, 1975) made collections on the R. Elan (W4) and suggested that net-sprinning Trichoptera and Simulidae, groups which might have been expected to be at an advantage in a river deriving its water from an impounded catchment (Hynes 1970), were not abundant and were probably adversely affected by 'brown deposits' on the river bed (Table 5). The composition of Truesdale's collection (kick samples from $0.125m^2$) in February 1975 was similar to that made in this study in March 1975 except for a higher representation of Chloroperlidae. Results from the present study, particularly those from September 1975, confirm that *Hydropsyche* spp were less abundant in the R. Elan in comparison to the R. Wye but there was no evidence that this was true for the Simuliidae.

Estimates of invertebrate density in March and September did not substantiate Truesdale's (1974, 1975) report that densities in the r. Elan were substantially lower than the R. Wye (Fig. 2).

The difficulty of dividing rivers into discrete zones based on the distribution of invertebrate communities is well documented (Hynes 1970; Hawkes 1975) and is substantiated by the current cluster analyses of R. Wye sites based on similarity coefficients. The sites, broadly separated into four groups of spatially adjacent sites when using data collected in September:-

W1
W2 – W6
W8 – W9
W10 – W13

Tributary sites (W4 and W7) seem associated with adjacent sites on the main river.

The more restricted March data would support spatially different associations in the reach between W3 and W9. There is nothing surprising in this conclusion for different environmental factors may be important in determining the distributions of the rather different invertebrate communities in spring and autumn. It is unfortunate from the surveillance viewpoint, however, that spatial associations which seem more labile include those sites (w5 – W8) likely to be, apart form W3, most affected by regulation.

2. <u>Benthic Invertebrate Studies at Key Sites</u>

<u>Results</u>

Monthly samples from W2 and W3 indicated that mean total invertebrate densities during 1975 ranged from 685 to 3057/m^2 and 802 to 2080/m^2 respectively (Fig 5). Estimates of density from contemporary samples from each site were never significantly different and the patterns of changes in density were generally similar, with highest densities recorded in July and lowest in May (Fig 5). Species of Ephemeroptera, Plecoptera, Trichoptera, Coleoptera and Chironomiidae were the most abundant macro-invertebrates at each site (Fig. 6, Appendix I and Table 6) and the general increase in abundance of all these groups during June and July was reflected in the significantly higher total densities ($P < 0.05$) in June compared with May.

During 1975, 92 taxa were collected from W2 and W3 (Table 6, Appendix 1): of these 57 were recorded during March and September when invertebrate 'surveys' were undertaken and the remainder (35) were collected at other times of the year. It is important to note that samples collected for survey purposes consist of four replicates which collect on average about 0% of the taxa practically available. If only four replicate samples had been taken on the total number of taxa recorded from W2 and W3 would have been 86. A high proportion (58-86%) OF TAXA NOT COLLECTED IN March and September were Diptera, principally Chironomidae (Table 6). Generally single taxa recorded during months other than March and September formed less than 3.0% of the total density at W2 and W3: only *Leuctra intermis* (9.7%) in April, *Peloscolex ferox* (4.2) in April and *Simulium variegatum* (3.4%) in July were more abundant.

The cumulative addition of taxa chronologically through 1975 indicated that after September no new taxa were collected. The inclusion of data from one further sampling data in addition to those in March and September increased the proportion of taxa sampled by between 8 to 19% (Table 7). For example, inclusion of samples collected in August increased the taxa collected from 62 to 81% of the total recorded.

The distribution of monthly occurrences of taxa not collected in March and September indicated that the majority of taxa were collected on one sampling occasion only though some taxa were recorded on several sampling occasions during the year (Table 6, Fig. 7a). By computing similar distributions including data from single additional sampling dates it is possible to select dates which include both single occurrence and multiple occurrence taxa in samples, e.g. March, August and September (Fig. 7b-d).

Discussion

Estimates of total invertebrate density in the R. Wye and similar to those recorded by other workers. Hynes (1961) estimated a mean density of $1437/m^2$ in Afon Hirnant in Wales and Morgan and Egglishaw (1965) reported densities ranging from 666 – $2064/m^2$ in streams in the Scottish Highlands. Summer densities of invertebrates in the headwaters of the R. Cynon in S. Wales were estimated at $2000/m^2$ (Learner *et al* 1971).

Whilst confidence limits for the invertebrate community have been computed (Fig. 4), such limits have not been calculated for individual taxa. When this has been completed production estimates will be attempted.

It is clear from samples taken at W2 and W3 throughout 1975 that about 62% of taxa are collected during March and September and such a situation is likely to obtain at other sites in the catchment (W1 – W13). Since those taxa which are not collected during March and September generally comprise, individually, less than 3% of the population, it is questionable whether information gained by including additional sampling dates is commensurate with the effort of collecting and processing samples, particularly when a large proportion of the additional taxa are Chironomidae, a taxonomically difficult group.

3. Invertebrate Drift

Results

Average total density of invertebrate drift, measured over a 24h period, at sites on the R. Wye (W2, W3, D1, W5) varied from 17 to 770 animals/$100m^3$ (Figs 8-11, Table 8). During March average densities were greater at W2 and W3, above the confluence with the R. Elan, than at W5, below the confluence. Later in the year, in July, the reverse was the case (Table 8). Estimates of total drift (assuming that drift samples are representative of the whole river) at stations on the R. Wye varied from 27 x 10^3 to 1190 x 10^3 organisms/24h (Table 8).

Average total drifting densities recorded in the R. Elan (W4) were always substantially lower than at sites on the R. Wye and varied between 6 and 80 animals/m^3 (Figs 8-11, Table 8). However, because of the higher summer discharge in the R. Elan than the R. Wye above its confluence, the total drift contribution of the R. Elan sometimes exceed that of the upper R. Wye (Table 8).

Comparison of results from three consecutive days)30, 31 May and 1 June) at W3 indicate that average and peak total densities varied from 80 to 180 animals/$100m^3$ respectively at a time when average river flow did not vary appreciably (Fig. 11a, Table 8).

Fifty-seven taxa were recorded from samples of drifting invertebrates: Plecoptera, Ephemeroptera, Chironomidae and Coleoptera were the most abundant organisms (Appendix II). Generally, fewer taxa were recorded from the R. Elan (W4) than from sites on the R. Wye.

In March the plecopterans *Amphinemura sulcicollis* and *Isoperla grammatical* were abundant at all sites: *Chlorperla* spp were collected from all sites on the R. Wye (Appendix II). Few nymphs of *Chloroperla* spp were recorded from samples taken at W4 (R. Elan) even though nymphs of these species formed a substantial proportion of the benthos (Appendix I). *Baetis* spp and *Rhithrogena semicolorata* were the most abundant ephemeropterans and were colleted from all sites on the R. Wye but at W4 (R. Elan) few nymphs of *Baetis* spp were collected and *R. semicolorata* was absent from drift samples. The coleopteran *Esolus parallelopipedus* often formed a substantial proportion of the drift at all sites except the R. Elan (appendix II).

In July the Ephemeroptera were relatively more abundant than in March and sites on the R. Wye were characterised by *Ephemerella ignite*, *Baetis* spp. and *E. parallelopipedus*. Except at W2 and W4 *Hydropsyche* spp were relatively abundant. The Chironomidae formed the major part of collections from the R. Elan (Fig 10).

Results from samples collected on 30, 31 May and 1 June at W3 indicate that the major components of drift on each of these days were generally similar, consisting of Chironomidae *Baetis* spp, *E. parallelopipedus* (Appendix II, Fig. 11a).

At all sites on the R. Wye invertebrate drift was characterised by diel periodicity. Those groups contributing to this periodicity were principally Ephemeroptera and Plecoptera (Figs 8-11). Lowest drift densities occurred during periods of daylight with a general increase in density during the hours of darkness. Except for two occasions at 3 (5 March and 31 May, Figs 8 and 11a) peaks of drifting density were recorded at or near to 24.00h (Figs 8-11). There was no evidence of diel fluctuations in the density of drifting organisms at W4 (R. Elan).

The experimental discharge of water from Caban Coch to the R. Elan (.53 up to 4.53 cumec) over the period 31 May – 1 June had a marked effect on invertebrate drift at W5 (Newbridge, 16 km from Caban Coch dam) (Fig 11b). On 30 May average drift density (river flow = 2.2 cumec) was 71 animals/100m^3 and peak density over the period 24.00 – 030.00h composed principally of *E. ignite*, was 170 animals/100m^3 (Fig. 11b). Increase in discharge was recorded at 15.00h on 31 May and average water velocity through the drift sampler increased from 0.35 to 0.51 m/sec. This was associated with an immediate increase in drift density from 73 to 290 animals/100m^3 during the daylight period 15.00-18.00h, substantially greater than the density at the same time the previous day. This increase in density of drifting organisms, principally Chironomidae, was sustained until 21.00h. The subsequent night-time peak density (24.00 – 03.00h), principally *E. ignita*, was considerably greater (590/100m^3) than the peak the previous night (170/100m^3). The following day, the second and final day of discharge, average and peak drift densities returned to pre-release levels – this implies, however, that total drift rate at this time of higher water flow, was higher than before the release (Table 8). During this experimental discharge drift densities at an upstream control station (W3), unaffected by the release, did not change appreciably except with respect to the diel rhythm (Fig. 11a).

Of the planktonic organisms discharged from Caban Coch into the R. Elan, four taxa have been identified: *Ceriodaphnia (quadrangular?), Diaptomus gracilis, Bosmina* sp. and Copepoda (indet.). Only *Ceriodaphnia* was abundant during drift studies and average densities of up to 790/1001 were recorded in water discharging from the dam (Table 9). Total loss of *Ceriodaphnia* from the dam was calculated to be 103 x 10^2/sec. At the confluence of the R. Elan and the R. Wye (6.5km from Caban Coch) total flow of *Ceriodaphnia* had decreased to about 25% of the original load: after 8 km (R. Wye) less than 8% of the original load of *Ceriodaphnia* was recorded (Fig. 12).

Discussion

Estimates of total drift/24h for sampling stations on the R. Wye and R. Elan are compared with the results of other workers, cited by Elliott and Corlett (1972), in Table 10.

The diel periodicity of drifting displayed by many organisms, particularly the Plecoptera and Ephemeroptera, has been described by many workers (Waters 1969, Elliott, 1969, Elliott and Minshall 1968): results from this study confirm the occurrence of night time increases in drifting density in the Wye catchment. Because of the long period of sampling (3h) it was not possible to isolate secondary peaks of drifting density (Elliott 1969).

No clear pattern of drifting periodicity was discerned in the R. Elan: it is possible that the characteristic low drifting density in this river made detection of such a pattern difficult. These low drifting densities in the R. Elan, with its compensated discharge (UWIST 1976a), may have important implications with respect to the proposal to regulate discharge in the R. Wye. There was no evidence that the density of benthic organisms was significantly lower than at sites on the R. Wye though some taxa were poorly represented.

The increase in daytime drift density (principally Chironomidae) and enhanced night-time peak of Ephemeroptera, resulting from an artificial discharge of water from Caban Coch, conflict with the results of other workers. Anderson and Lehmkuhl (1968) recorded a four fold increase in drift rate during a natural freshet but there was no indication of an increase in drift density: Elliott (1967) also reported that increased drifting density did not result from an increase in discharge.

Plankton often form an important component of drift below reservoir outflows (Hynes 1970, Chandler 1937). Generally, as in the R. Elan, the quantity of lake plankton rapidly decreases with increasing distance from the outflow and this is likely to be influenced by flow, topography and the presence of aquatic macrophytes. Chandler (1937) reported that plankton density 8 km from a lake outfall to the Huron River varied from 12/1 to 16896/1. The influence of lake plankton was still significant at 30 km from a lake outflow in a large Swedish river with a flow of 200 cumec (Muller 1956) but was insignificant at about 200m from an outflow into a small stream, with a flow between 0.4 – 0.8 cumec (Illies 1956). Comparison of daily estimates of total copepoda and Cladocera drifting from Caban Coch into the R. Elan and from Windermere into the R. Leven are shown in Talbe 11. It is significant that those organisms best able to utilise these planktonic organisms as a food source are poorly represented in the R. Elan (e.g. *Hydropsyche* spp.).

References

Anderson, N.H. and Lehmkuhl, D.M. (1968). Catastrophic drift of insects in a woodland stream. *Ecology*, **49**, 198–200.

Armitage, P.D., MacHale, A.M. & Crisp, D.C. (1974). A survey of stream invertebrates in the Cow Green basin (Upper Teesdale) before inundation. *Freshwat. Biol.* **4**, 369-98.

Armitage, P.D., MacHale, A.M. & Crisp, D.C. (1975). A survey of the invertebrates of four streams in the Moor House National Nature Reserve of Northern England. *Freshwat. Biol.* **5**, 479-95.

Bailey, R.G. (1966). Observations on the nature and importance of organic drift in a Devon river. *Hydrobiologia* **27**, 353-67.

Bishop, J.E. & Hynes, H.B.N. (1969). Downstream drift of the invertebrate fauna in a stream ecosystem. *Arch. Hydrobiol.* **66**, 56-90.

Chandler, D.c. (1937). Fate of typical lake plankton in streams. *Ecol. Monogr.* **7**, 445-79.

Elliott, J.M. (1967). Invertebrate drift in a Dartmoor Stream. *Arch. Hydrobiol.* **563**, 202-37.

Elliott, J.M. (1969). Diel periodicity in invertebrate drift and the effect of different sampling periods. *Oikos*, **20**, 524-28.

Elliott, J.M. (1970). Methods of sampling invertebrate drift in running water. *Ann. Limnol.* **6**, 133-50.

Elliott, J.M. & Corlett, J. (1972). The ecology of Morecombe Bay IV. Invertebrate drift into and from the R. Leven. *J. Appl. Ecol.* **9**, 195-205.

Elliott, J.M. & Minshall G.W. (1968). The invertebrate drift in the River Duddon, English Lake District. *Oikos*, **19**, 39-52.

Hawkes, H.A. (1975). River zonation and classification. In: *River Ecology* Ed. B.A. Whitton. Blackwell Scientific Publications, 312-74.

Hynes, H.B.N. (1970). The Ecology of Running Waters. Liverpool University Press.

Illies, J. (1956). Seausfluss – Biozonosen Caplandischer Waldbache. *Ent. Tidskr* **77**, 138-53.

Learner, M.A., Williams, R., Harcup, M. & Hughes, B.D. A survey of the macro-fauna of the River Cynon, a polluted tributary of the River Taff (South Wales). *Freshwat. Biol.* **1**, 339-67.

Minshall, G.W. & Kuehne, R.A. (1969). An ecological study of invertebrates of the Duddon, an English mountain stream. *Arch. Hydrobiol.* B66B, 169-91.

Morgan, N.C. (1970). Freshwaters. *Nature Conservancy Report for Nature Conservation Review Year,* 1970.

Morgan, N.C. & Egglishaw, J.H. (1965). A survey of the bottom fauna of streams in the Scottish Highlands. Part I. Composition of the fauna. *Hydrobiologia*, **25**, 181-211.

Muller, K. (1956). Das produkitionsbiologische Zusammenspiel zwischen See und Fluss. *Ber. Limn. Flusstn. Freudenthal.* **7**, 1-8.

Shannon, C.E. (1948). A mathematical theory of communication. *Bell syst. Tech. J.* **27**: 379-423, 623-656.

Sneath, P.H.A. & Sokal, R.R. (1973). Numerical taxonomy. W. H. Freeman & Co.

Truesdale, G.A. (1974). Final report on quality aspects of water impoundement and inter-river transfers. Craig Goch Joint Committee, Craig Goch Reservoir Investigations, November 1974.

Truesdale, G.A. (1975). Further investigations into the occurrence and effects of surface deposits in the proposed Craig Goch system. Craig Goch Joint Committee, Craig Goch Reservoir Investigations, November 1975.

Ulfstrand, S. (1968). Benthic animal communities in Lapland streams. *Oikos*,, Suppl. 10pp, 120.

UWIST (1976a). Water Quality – R. Wye. Craig Goch Field Surveys Group Meeting, Malvern. February 1976. UWIST Paper 1.

UWIST (1976c). Comparison of two methods of collecting macro-invertebrates from the R. Wye. Craig Goch Field Surveys Group Meeting, Malvern. February 1976. UWIST Paper 3.

Waters, T.F. (1962). Diurnal periodicity in the drift of stream invertebrates. *Ecology*. **46**, 327-34.

Appendix 1 – Macroinvertebrates recorded from the R. Wye and tributaries (No./m^2)

Date	March 1975										September 1975												
Stations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Coelenterata	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-
Hydra																							
Platyhelminthes																							
Phagocata vitta	40	250	5	45	-	35	10	15	-	-	5	30	10	30	-	5	60	-	-	-	-	-	-
Planaria torva	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40	1295	85	20
Fematoda	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	70	-	-
Annelida (Oligochaeta)																							
Enchytraeidae	-	-	30	-	45	90	155	25	10	-	-	5	20	15	30	15	30	15	100	-	-	30	5
Tubificidae																							5
Limnodrilus hofmeistteri	-	-	-	-	-	-	-	5	-	35	-	-	-	-	-	-	-	-	-	30	-	10	-
Rhyacodrilus coccineus	-	-	-	-	-	5	245	240	15	-	-	-	-	-	-	140	-	75	50	320	20	90	5
Ploscolex ferox	-	-	-	-	-	-	20	35	5	-	-	-	-	-	5	-	-	-	60	20	40	80	5
Aulodrilus pluriseta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
Psammoryctides barbatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	110	10
Lumbriculidae																							
Stylodrilus heringianus	-	-	-	-	10	65	110	175	75	85	-	5	-	75	25	280	310	80	235	760	235	485	5
Lumbriculus variegatus	-	-	-	165	100	-	105	-	5	25	-	5	-	200	115	175	240	30	30	70	1345	735	-
Naididae																							
Nais alpina	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-
Stylaria lacustris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	85
Nais elinguis	-	-	-	-	-	580	-	-	10	-													
Lumbricidae																							
?	30	5	10	20	70	-	80	45	-	-	20	15	20	20	160	85	15	60	20	60	90	10	10
Eiseniella tetrahedra	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Annelidae (Hirudinea)																							
Glossiphonidae																							
Helobdella stagnalis	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	10	30	40	5
Glossiphonia complanata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	20	20
Erpobdellidae																							
Erpobdella octoculata	-	-	-	30	15	10	-	25	15	-	-	-	-	20	5	120	-	20	60	50	-	45	115
Piscicolidae																							
Piscicola geometra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5

Date	March 1975										September 1975												
Stations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Arthropoda (Crustacea)																							
Gammaridae																							
Gammarus pulex	-	-	-	-	-	-	-	-	-	130	-	-	-	-	-	-	-	-	60	380	120	30	150
Asellidae																							
Asellus aquaticus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	-	-	-	-	20
Cyprididae																							
Herpetocypris reptans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
Arthropoda (Insecta)																							
Leuctridae																							
Leuctra hippopus	25	90	15	-	5	-	10	10	-	30	-	10	10	40	135	1450	35	135	330	140	30	-	-
L. moselyi	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	15	505	-	95	-	30	-	-
L. inermis	5	-	-	365	120	60	15	45	30	5	-	-	-	-	-	-	30	-	-	-	-	-	-
L. nigra	-	-	5	-	-	-	-	-	-	-													
L. geniculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	15
V. small *Leuctra*	-	-	-	-	-	580	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemouridae																							
Protonemura meyeri	25	50	40	-	20	5	-	-	-	-	25	-	-	-	-	-	20	5	-	-	-	-	-
Amphinemura sulcicollis	275	165	120	470	105	10	5	30	10	-	-	35	-	-	-	15	20	-	-	-	-	-	-
Nemoura sp.	5	-	-	-	-	-	-	-	-	-													
Perlidae																							
Perla bipunctata	-	10	15	-	-	15	-	-	2	-	-	15	15	-	5	35	35	20	-	-	-	-	-
Dinocras cephalotes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-
Chloroperlidae																							
Chloroperla torrentium	20	245	130	230	150	60	45	55	15	-	-	15	35	-	5	15	-	-	-	-	-	-	-
Chloroperla tripunctata	15	145	130	5	125	110	5	25	-	-	-	5	-	-	15	15	-	-	-	-	-	-	-
Perlodidae																							
Isoperla obscura	-	40	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isoperla grammatical	-	-	-	235	40	20	35	25	10	15	-	5	60	-	5	-	45	5	-	-	-	-	-
Perlodes microcephala	-	-	-	35	-	-	10	-	5	-	-	-	-	30	-	-	-	-	-	10	-	-	-
Taeniopterygidae																							
Brachyptera risi	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhabdiopteryx acuminata	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Date	March 1975										September 1975												
Stations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Baetidae																							
Baetis rhodani	-	35	45	20	145	60	225	65	80	20	-	150	45	55	20	315	505	103	1295	250	885	50	110
B. scambus	-	-	-	-	-	-	-	-	-	-	5	65	20	45	40	255	-	70	120	285	930	40	-
B. muticus	-	-	-	-	-	-	-	-	-	-	5	-	10	-	20	70	15	-	75	45	150	-	-
B. niger	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	30	-	90
Potamanthidae																							
Potamanthus luteus	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenidae																							
Caenis moesta	-	-	-	-	500	1990	10	195	20	145	-	-	-	-	-	-	25	65	20	120	-	55	100
Heptageniidae																							
Ecdyonurus dispar	-	-	-	-	-	-	-	-	-	10	5	195	65	-	25	55	-	10	-	10	-	-	-
Rithrogena semicolorata	-	105	215	-	430	325	290	690	900	55	-	125	20	-	5	1175	770	160	10	140	-	-	-
Heptagena sulphurea	-	-	-	-	-	5	-	-	10	45	-	-	-	-	15	35	-	245	330	170	150	125	40
Ephemerellidae																							
Ephemerella ignita	-	-	-	-	-	-	-	-	-	-	5	10	-	5	5	-	-	-	-	-	-	-	-
Ephemeridae																							
Ephemera danica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	15	40
Aphelocheridae																							
Aphelocheirus montandoni	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-	-	-	25	120	200	250
Limoniinae																							
Dicranota sp.	5	5	20	50	25	10	15	20	30	20	55	25	30	65	5	10	1180	30	10	40	30	-	-
Rhagionidae																							
Atherix sp.	10	-	15	-	10	-	-	5	-	10	-	45	55	-	5	10	20	30	20	-	-	5	10
Tipulidae	-	-	-	-	-	-	-	-	-	-	-	-	10	10	5	-	-	-	-	-	-	-	-
Glossosomatidae																							
Glossosoma conformis	-	-	5	-	10	10	30	65	-	5	-	-	10	-	-	-	-	-	-	-	-	5	-
Hydropsychidae																							
Hydropsyche sittaliai	-	15	60	-	150	15	15	45	5	-	45	410	325	5	240	485	2415	160	20	-	-	-	-
H. pellucidula	-	5	40	-	5	-	-	10	-	10	10	120	80	25	60	265	50	30	890	85	180	145	45
H. contubernalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	65	310	280	50
Cheumatopsyche lepida	-	-	-	-	-	-	-	-	25	-	-	-	-	-	-	-	30	530	1920	40	3570	185	225
Polycentropidae																							
Polycentropus kingi	-	10	-	5	10	10	-	-	-	-	-	80	15	25	30	55	-	30	-	-	-	110	100
Holocentropus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	190	90	-	-	480	-
Plectrocnemia conspersa	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptoceridae (indet)	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Date	March 1975										September 1975												
Stations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Rhyacophilidae *Rhyacophila dosalis*	-	-	-	15	15	10	-	5	-	-	-	30	25	15	30	55	-	10	95	-	-	-	-
Sericostomatidae *Brachycentrus subnubilis*	-	-	-	-	-	-	-	-	-	55	-	-	-	-	-	5	-	-	210	20	90	-	25
Beraeidae (?)	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elminthidae* *Elmis aenea*	-	-	0 5	-	20 10	0 10	-	0 20	-	-	-	-	-	-	0 15	-	0 25	0 20	20 380	0 10	0 90	0 45	0 5
Esolus parallelopipedus	-	-	260 50	-	-	150 80	0 60	20 15	0 55	100 60	-	0 30	-	-	0 30	10 240	165 450	145 360	80 210	0 35	0 260	0 35	0 45
Limnius volckmari	0 15	-	0 10	0 15	0 20	5 20	0 10	100 100	0 15	-	0 10	15 10	0 0	-	0 15	0 20	0 50	0 60	15 205	5 185	0 240	15 330	10 55
Oulimnius tuberculatus	-	15 10	5 5	-	55 15	10 45	25 0	0 85	-	25 5	-	-	0 10	-	0 50	0 10	0 270	0 20	0 30	0 15	180 1230	25 1210	40 210
Gyrinidae	-	5	5	-	5	-	-	-	5	5													
Curculionid sp. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-
Coleoptera sp. Indet.	-	-	15	-	-	15	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	15	-
Sialidae																							
Sialis lutaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
S. fulginosa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	25
Chironomidae (Tanypodinae)	15	10	-	5	5	-	-	-	5	-	30	20	40	5	15	5	45	5	-	-	10	-	-
Pentaneura sp. 1	-	-	-	-	-	-	-	-	-	-	35	-	10	-	-	-	-	-	-	5	-	-	5
sp. 2	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	5	-	5	-	-	-	-	-
sp. 3																							
Procladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	135
(Orthocladiinae)																							
Eukiefferiella sp. 1	-	-	-	-	10	5	-	-	5	-	-	-	-	-	25	-	250	-	180	-	-	-	-
sp. 2	-	5	5	-	125	-	155	-	5	-	40	100	10	10	110	-	20	-	-	-	-	-	-
sp. 3	-	-	10	-	45	20	5	15	5	-	-	-	-	-	-	-	160	-	-	-	-	-	-
sp. 4	20	10	-	-	15	20	10	35	-	-	-	55	-	-	-	-	-	200	-	-	15	-	-
sp. 5	50	-	-	-	-	10	30	20	-	-	-	-	-	-	-	-	-	-	40	-	-	-	-
sp. 6	15	-	-	-	-	-	-	5	5	-	-	-	-	-	-	-	-	10	210	-	-	-	-
Brillia modesta	-	-	-	5	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-

Date	March 1975										September 1975												
Stations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Orthocladius sp. 1	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-
sp. 2 *(O. rubicundus)*	-	-	-	-	-	200	-	930	50	-	-	-	-	-	5	25	-	-	-	30	-	-	-
sp. 3	-	-	-	-	-	-	-	30	-	-	-	-	-	-	-	-	15	-	-	-	15	-	-
sp. 4	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	1270	-	-	-	-	-	-	-
sp. 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-
sp. 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-
sp. 7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	-	5	540	75	-
sp. 8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
sp. 9	-	-	-	-	-	-	-	-	-	-	70	30	15	100	100	-	-	-	40	-	-	-	-
Synorthocladius semivirens	-	-	-	-	-	-	-	-	-	-	-	5	5	-	-	-	-	-	-	25	35	35	-
Cricotopus bicinctus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	75	-	-	30	-
C. trifascia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	110	-	-	-	1535	35	-
Cricotopus sp. 1	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	10	-	-	-	-	10	-	-
sp. 2 (*C. albiforceps* ?)	25	-	-	30	35	-	-	-	-	-	-	-	-	-	-	-	-	-	360	-	-	-	-
Metriocnemus sp.	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cricotopus 'fuscus' type	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-
Rheocricotopus sp.	-	-	-	-	-	-	-	-	-	-	-	-	60	-	40	-	-	-	-	-	515	30	5
Coryoneurinae																							
Thienemanniella sp. 1	-	1	-	-	5	-	-	-	-	-	-	-	5	-	20	-	-	-	-	-	-	-	-
sp. 2	-	0 -	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	10	-	-	-
Diamesinae																							
Diamesa sp. 1	70	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sp. 2	30	-	10	5	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-
sp. 3	15	-	-	-	-	-	-	-	-	-	240	20	-	20	10	-	120	-	10	-	-	-	-
Prodiamesa olivacea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-
Chironominae																							
Polypedilum 'laetum'	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	575	70	10	10	-	-	-	-
'nubeculosum'	-	-	-	-	-	-	-	-	-	10	-	25	5	-	20	-	120	-	40	-	-	-	10
'convictum'	-	-	-	-	-	-	-	-	-	-													
Rheotanytarsus sp.	-	-	-	-	-	-	-	-	-	-	-	10	15	-	20	55	45	25	540	10	85	65	-
Microtendipes sp.	-	-	-	-	-	-	-	-	-	25	-	5	-	-	-	-	-	-	10	5	-	60	10
Paralauterborniella sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30	155	110	90
Cryptochironomus sp. 1	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	45	5
sp. 2 ('varus')	-	-	-	-	-	-	-	-	-	-													
Lauterbornia sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	75	-	-	-	5	-	-	15	55	110
Phaenopsectra sp.	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10

Date	March 1975										September 1975												
Stations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Endochironomous sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Xenochironomus xenolabis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-
Ceratopogonidae sp. A	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-
sp. B	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Simulidae																							
Simulium brevicaule	210	-	-	-	-	-	65	-	-	-	(5)	(5)	(5)	-	-	-	-	-	-	-	-	-	-
S. monticola	10	-	-	-	-	40	-	-	-	-													
S. ornatum	-	-	-	-	-	-	-	-	-	-	20	-	-	(5)	-	-	20	-	190	-	30	-	-
sp. F	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S. variegatum	-	-	-	-	-	40	20	-	5	-	-	-	-	-	-	(15)	220	-	115	-	-	-	-
S. zetlandense	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	4240	20	-	-	-	390	5	-
S. nitidifrons	-	-	-	-	-	-	-	-	-	-	-	85	-	-	-	-	-	-	-	-	-	-	-
S. aureum gp.	-	-	-	-	-	-	-	-	-	-	5	50	10	5	-	370	(25)	-	-	-	-	-	-
sp. A	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
sp. D	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arthropoda (Arachnida) *Hydracarina* indet. A	-	-	-	-	-	-	-	-	-	5	-	-	-	-	10	10	-	-	10	-	-	-	-
Mollusca *Ancylidae* *Ancylus fluviatilis*	-	-	-	-	-	-	-	-	-	-	-	15	5	-	200	-	-	-	340	35	120	360	-
Hydrobiidae																							
Potamopyrgus jenkinsi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-
Bithynia leachi/tentaculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	45	120
Physidae *Physa fortinalis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
Neritidae *Theodoxus fluviatilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	70
Planorbidae *Planorbis albus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	50
Lymnaeidae *Lymnaea peregra*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
Pisidium sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	75	10	300	150	80
B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	-	-	20
C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45	-	90	40	15
Total density (no/m^2)	945	1285	1360	1710	2730	4765	1940	3270	1475	983	635	1895	1110	935	1705	12035	8780	2995	9530	3645	15660	6355	2830
Total No. of species groups	24	22	29	21	33	37	33	36	33	29	19	39	36	28	43	42	45	41	53	44	44	51	52
Total No. of species groups	88										126												
Total No. of chironomid species or species groups	23										42												

Where groups were not collected this is denoted by a – *adults
Larvae

Appendix II Percentage, Composition of Invertebrate Drift

Date	10 March 1975				30 May	31 May	1 June	30 May	31 May	1 June	30 May		
	W2	W3	W4	W5	W3	W3	W3	W5	W5	W5	W2	D1	W4
Leuctra hippopus	-	-	-	1	-	-	-	-	-	-	-	-	-
L. moselyi	-	-	-	-	1	+	+	-	-	-	-	-	-
L. inermis	2	+	3	5	-	-	-	-	-	-	-	-	2
L. nigra	-	-	-	1	+	-	-	-	-	-	-	-	-
L. geniculata	-	-	-	-	-	-	-	-	+	-	-	-	-
Protonemura meyeri	15	8	-	3	-	-	+	+	-	-	-	+	-
Amphinemura sulcicollis	18	10	29	6	-	-	+	-	1	1	+	-	-
Nemoura cabrica	1	+	-	3	-	-	-	-	+	-	-	-	-
Perla bipunctata	-	+	-	+	-	-	-	-	-	-	-	-	-
Chloroperla torrentium	+	3	-	3	2	1	2	1	1	4	1	+	-
C. tripunctata	3	15	1	3	-	-	-	-	1	+	-	-	8
Isoperla obscura	-	-	-	1	-	-	-	-	-	-	-	-	-
I. grammatica	5	6	27	3	+	-	2	-	+	+	-	2	-
Perlodes microcephala	-	+	-	-	-	-	-	-	-	-	-	-	-
Bracju[tera roso	5	+	3	1	-	-	-	-	-	-	-	-	-
Baetis rhondani	16	18	1	6	3	+	+	7	+	+	-	+	4
B. scambus	-	-	-	-	2	19	25	+	2	2	4	59	19
B. muticus	-	-	-	-	+	+	-	-	+	-	-	2	-
B. niger	-	-	-	-	-	-	+	-	-	-	-	-	-
Caenis moesta	-	-	-	2	-	-	-	+	+	+	-	-	-
Ecdyonurus dispar	-	+	-	-	+	-	-	2	-	-	-	-	-
Rithrogena semicolorata	5	8	-	41	4	-	-	+	2	2	-	4	-
Heptagena sulphurea	-	-	-	-	+	-	-	-	+	-	-	-	-
Ephemerella ignita	-	-	-	-	3	5	8	23	26	35	1	1	-
Paraleptophlebia cincta	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsyche siltalai	1	2	-	-	11	11	13	1	3	+	1	17	-
H. pellucidula	+	1	-	-	-	-	-	-	-	-	-	-	-
Polycentropus sp.	-	-	-	-	-	-	+	-	+	-	1	-	-
Keoticerudae	1	1	-	1	-	+	-	-	-	-	+	-	-
Glossoma conformis	1	+	-	1	-	-	-	-	-	-	-	-	-
Rhyacophila dorsalis	-	+	-	-	-	+	+	-	+	-	-	-	-
Sericostomatidae	-	-	-	-	-	-	+	-	3	1	-	-	-
Limnephilidae	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironomidae	4	6	12	9	2	23	22	48	43	44	16	8	65
Simuliidae	4	+	9	2	1	2	+	1	5	+	3	2	2

Date	10 March 1975				30 May	31 May	1 June	30 May	31 May	1 June	30 May		
	W2	**W3**	**W4**	**W5**	**W3**	**W3**	**W3**	**W5**	**W5**	**W5**	**W2**	**D1**	**W4**
Elmis aenea	1	+	-	-	5	2	1	-	1	1	+	-	-
Esolus parallelopipedus	8	4	1	1	51	24	19	14	4	3	71	7	-
Limnius volkmari	-	+	-	-	2	+	+	-	+	+	1	+	-
Oulimnius tuberculatus	2	+	-	-	3	2	4	1	+	1	1	-	-
Dytiscidae	-	-	-	-	1	2	1	+	+	-	-	2	-
Curculionid sp. A	+	1	1	-	-	-	-	-	+	+	+	-	-
Coleoptera sp. indet.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ceratopogonidae	+	-	-	-	-	-	-	-	-	-	-	-	-
Hydracarina	-	2	3	-	1	2	1	-	2	3	-	+	-
Oligochaeta	-	-	-	-	-	-	-	-	2	+	-	-	-

+ = less than 1%

- = 0

Table 1

Sampling Sites, Wye Catchment

Sites			Distance from source (km)
W1	Pant mawr	SN 843827	7
W2	Deep Pool	SN 921739	20
W3	Rhayader	SN 921739	34
W4	R. Elan*	SN 939661	-
W5	Newbridge	SO 015582	48
W6	Builth Wells	SO 043513	60
W7	R. Irfon*	SO 032510	-
W8	Erwood	SO 115414	70
W9	Glasbury	SO 180394	85
W10	Bredwardine	SO 336447	117
W11	Ross	ST 588241	183
W12	Symonds Yat	ST 568182	202
W13	Redbrook	ST 535101	220

** Tributaries*
Proposed regulation discharge between sites W2 and W3

Table 2

Site Characteristics, March and September 1973

Sites	March		September	
	Velocity (cm/sec)	Depth (cm)	Velocity (cm/sec)	Depth (cm)
W1	56	12	22	9
W2	54	22	54	18
W3	73	29	51	18
W4	45	20	36	20
W5	70	24	42	19
W6	101	21	80	21
W7	85	25	61	12
W8	94	37	35	23
W9	93	20	72	22
W10	37	63	51	29
W11	-	-	67	26
W12	-	-	33	36
W13	-	-	19	47

Table 3

Total mean densities and 95% confidence limits (calculated after log transformation) and diversity indices H' (Shannon, 1948) at sites on R. Wye, March and September 1975

Sites	March			September		
	Arithmetic mean (no/m^2)	95% confidence limits (no.m^2)	H'	Arithmetic mean (no/m^2)	95% confidence limits (no.m^2)	H'
W1	945	260-2240	3.477	635	600-820	3.230
W2	1285	990-1700	3.357	1895	1110-3340	4.266
W3	1360	1156-1660	3.752	1110	374-2940	4.175
W4	1710	822-3238	3.117	935	558-2520	4.045
W5	2730	1500-3594	4.006	1705	552-4156	4.464
W6	4765	1538-11870	3.117	12035	5820-17600	3.432
W7	1940	1055-3088	4.117	8780	4580-13660	3.431
W8	3270	1187-7058	3.579	2995	1503-6036	4.252
W9	1475	617-2874	2.638	9530	7180-14388	4.385
W10	983	498-2212	4.019	3645	2492-5540	4.273
W11	-	-	-	15660	7020-30060	4.056
W12	-	-	-	6355	2980-12520	4.344
W13	-	-	-	2880	276-13976	4.869

Table 4 – Percentage representation of total numbers of macro-invertebrates collected, 1975

	March												
	W1	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**W9**	**W10**	**W11**	**W12**	**W13**
Platyhelminthes	4.2	19.4	0	2.6	0	0.7	0.5	0.5	0	0	-	-	-
Oligochaeta	3.2	0.3	2.9	10.7	8.9	15.5	32.3	15.8	8.8	14.7	-	-	-
Hirudinea	0	0	0	1.7	0.5	0.3	0.3	0.9	0.6	1.0	-	-	-
Plecoptera	39.5	61.4	39.3	78.3	22.5	18.0	6.4	5.8	6.4	5.0	-	-	-
Ephemeroptera	0	10.8	19.9	1.1	42.9	49.6	27.0	32.0	68.8	28.4	-	-	-
Trichoptera	0	2.7	8.0	1.4	7.5	1.4	1.1	3.9	2.0	7.1	-	-	-
Coleoptera	1.5	2.0	24.3	0.1	4.7	6.7	5.4	7.8	4.7	19.2	-	-	-
Crustacea	0	0	0	0	0	0	0	0	0	13.2	-	-	-
Chironomidae	25.3	3.1	1.8	2.9	9.5	5.3	12.6	31.8	5.0	4.5	-	-	-
Simuliidae	24.8	0	0	0	0	0.8	4.6	0	0	0	-	-	-
Mollusca	0	0	0	0	0	0	0	0	0	0	-	-	-
Others	1.5	0.3	2.5	2.2	3.5	1.2	9.1	0.9	3.7	6.9	-	-	-

	September												
	W1	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**W9**	**W10**	**W11**	**W12**	**W13**
Platyhelminthes	0.7	1.5	0.9	3.2	0	0	0.6	0	0	1.1	11.1	1.3	0.7
Oligochaeta	3.1	1.5	4.9	35.5	20.8	5.7	6.0	8.2	5.6	35.0	11.0	24.0	6.7
Hirudinea	0	0	0	2.0	0.2	1.0	0	0.6	0.6	1.3	0	0.7	4.1
Plecoptera	4.7	4.5	10.8	7.5	9.1	12.9	8.8	5.2	4.6	4.2	0.3	0.3	0.5
Ephemeroptera	3.0	30.0	14.4	11.4	7.9	15.9	14.7	21.0	19.2	28.4	4.1	4.5	13.9
Trichoptera	8.6	33.9	40.9	7.5	21.1	7.2	28.6	31.0	34.8	5.8	25.7	18.7	17.3
Coleoptera	0.2	3.1	2.7	0	6.2	2.4	11.5	19.8	11.0	6.9	12.7	26.8	13.3
Crustacea	0	0	0	0	0	0	06	0	0.6	1.05	7.0	0.6	6.2
Chironomidae	65.3	14.5	15.3	24.8	22.4	15.7	10.9	12.0	16.3	4.1	18.0	8.5	15.5
Simuliidae	4.7	7.4	1.3	1.0	0.2	38.7	2.9	0	3.2	0	2.6	0	0
Mollusca	0	0.7	0.4	0	11.7	0	0	0	3.8	1.9	3.1	9.4	15.8
Others	9.7	4.6	8.4	9.1	0.4	0.5	15.4	2.2	0.3	0.8	4.4	5.2	8.0

Table 5

Percentage representation of macro-invertebrates collected at Station 5 (Truesdale 1974) W4 UWIST (Taken from Truesdale 1974, 1975).

	March 1974	August 1974	February 1975
Platyhelminthes	0	0	0.7
Oligochaeta	3.1	10.3	26.4
Hirudinea	1.2	1.9	0
Plecoptera	52.2	7.4	59.6
Ephemeroptera	2.3	21.1	0
Rhyacophilidae*	1.2	1.2	0.7
Campodeiform*	7.4	4.6	0.7
Cruciform*	3.1	0.7	2.0
Simuliidae	1.6	8.6	2.0
Chironomidae	20.5	26.0	1.7
Others	7.4	18.2	6.2
Total density(no/m^2)	728	538	797

** Tricoptera*

Table 6

Taxa collected from W2 and W3 during 1975 but not collected during qualitative surveys (March and September)

April	May	June
Oligochaeta *Peloscolex ferox* (4.2) Plecoptera *Leuctra inermis* (9.7) *Brachyptera risi* (1.2) Trichoptera *Potamophylax* sp. (-) Chironomidae *Cricotopus* sp. 1* (0.6) *Orthocladius* sp. 5 (1.8) *Brillia modesta** (-) *Lauterbornia* sp.* (-) Simuliidae *Simulium reptans* (1.9)	Oligochaeta *Peloscolex ferox* (2.1) Plecoptera *L. inermis* (1.5) Chironomidae *Cricoteopus* sp. 1* (-) *Orthocladius* sp. 2 (0.4) sp. 5* (0.4) sp. 6* (0.8) Simuliidae *Simulium variegatum* (0.9) Cerantopogonidae Indet. (-)	Oligochaeta *Peloscolex ferox* (0.3) Plecoptera *L. inermis* (0.2) Ephemeroptera *Caenis moesta** (-) Chironomidae *Pentaneura* sp. 3 (0.9) *Cricotopus* sp. 1 (0.4) sp. 2* (-) *Orthocladius* sp. 2 (0.2) sp. 3 (0.3) *Eukiefferiella* sp. 5 (0.2) *Lauterbornia* sp.* (-) Simuliidae *S. reptans* (2.9) *S. variegatum** (0.3)
No. of taxa = 9 No. of Chironomidae = 4 No. of replicates = 8	No. of taxa = 10 No. of Chironomidae = 5 No. of replicates = 15	No. of taxa = 12 No. of Chironomidae = 7 No. of replicates = 8

Figures in parentheses indicate the maximum density of taxa as a percentage of total density.
- = less than 0.2%
** = would not have been collected if only 4 replicates at each site.*

Table 6 – (cont'd)

Taxa collected from W2 and W3 during 1975 but not collected during qualitative surveys (March & September)

July	August	October	November
Oligochaeta *Peloscolex ferox* (-) *Eclipodrilus* sp. (0.3) Plecoptera *L. inermis* (0.5) Ephemeroptera *C. moesta* * Chironomidae *Pentaneura* sp. (0.8) *Cricotopus* sp. 1* (-) *Orthocladius* sp. 3* (0.4) *Eukiefferiella* sp. 1 (0.8) sp. 5 (-) *Brillia modesta* (0.7) *Polypedilum convictum* (2.0) Simulidae *S. naturale* (0.7) *S. monticola* (-) *S. variegatum* (3.4) *S. zetlandense** (-)	Oligochaeta *Pristina* sp. (-) Plecoptera *L. inermis (0.3)* *Perlodes microcephala* (-) Ephemeroptera *Baetis niger* (-) Trichoptera *Hydropsyche contubernalis** (-) Chironomidae *Pentoneura* sp. 4 (0.3) *Cricotopus* sp. 1 (-) *Eukiefferiella* sp. 1 (1.2) sp. 5* (-) sp. 6 (0.6) *Diamesa campestris* (1.2) *Polypedilum convictum* (0.3) *P. laetum** (-) Simuliidae *S. reptans* (2.0) *S. latipes* (2.7) *S. ornatum* (-) *S. erythrocephalum** (-)	Ephemeroptera *C. moesta* (0.3) Chironomidae *Eukiefferiella* sp. 1* (0.6) sp. 5 (0.3) sp. 6* (0.3) *Diamesa campestris* (0.3) Simuliidae *S. variegatum* (0.9) *S. latipes* (0.6)	Plecoptera *L. inermis* (1.5) Ephemeroptera *C. moesta* (-) Chironomidae *Cricotopus* sp. 1* (0.7) *Eukiefferiella* sp. 5* (-) *Diamesa campestris* (-) Simuliidae *S. reptans* (2.1) *S. monticola* (-)
No. of taxa = 14 No. of Chironomidae = 7 No. of replicates = 8	No. of taxa = 17 No. of Chironomidae = 8 No. of replicates = 8	No. of taxa = 7 No. of Chironomidae = 4 No. of replicates = 8	No. of taxa = 7 No. of Chironomidae = 3 No. of replicates = 8

Figures in parentheses indicate the maximum density of taxa as a percentage of total density.
- = less than 0.2%

Table 7

Percentage of taxa sampled on different dates

Sampling Dates	% of taxa sampled
March and September	62
March, April and September	70
March, May and September	73
March, June and September	76
March, July and September	76
March, August and September	81
March, September and October	71
March, September and November	71

Table 8

Density of drifting invertebrates in the R. Wye and R. Elan, 1975

Date	Site	Ave. total density (no/100m^3) (24 h period)	Max. total density (no/100m^3) (3h period)	Total drift (no x 10^3/24h)	Ave. river discharge (cumec)	Ave. water velocity through sampler (m/s)
5 March	W2	21	53	103	5.7	0.60
	W3	41	99	225	6.3	0.60
	W4	6	9	8	1.5	0.39
	W5	17	43	115	7.9	0.59
30 May	W2	98	340	52	0.6	0.30
	W3	130	490	99	0.7	0.27
	W4	18	30	25	1.5	0.27
	D1	80	370	152	2.2	0.28
	W5	71	170	135	2.2	0.35
31 May*	W3	80	310	47	0.7	0.28
	W5	200	590	745	4.3	0.51
1 June*	W3	130	650	76	0.7	0.27
	W5	90	190	335	4.3	0.51
10 July	W2	200	590	39	0.2	0.36
	W3	120	350	27	0.3	0.24
	W4	80	160	105	1.5	0.20
	D1	620	2380	958	1.8	0.32
	W5	770	2951	1190	1.8	0.39

** Freshet release.*

Table 9

Density of planktonic organisms (No./1001) in R. Elan and R. Wye. 11 October 1975

Site	Distance from dam (km)	*Ceriodaphnia*	*Diaptomus*	*Bosmina*	*Copepoda*
Dam Valve 1	0	600 (115)	15 (5)	3 (6)	8 (4)
Dam Valve 2	0	790 (44)	10 (10)	7 (12)	10 (17)
R. Elan	0.8	723 (143)	13 (19)	2 (3)	7 (8)
R. Elan	4.0	361 (76)	15 (13)	8 (3)	7 (3)
R. Wye	8.0	11 (13)	0	0	0

Figures in parentheses = standard deviation
3 samples at each site.

Table 10

Estimates of total invertebrate drift/24h

Site	Total drift (No/24h)	Authority
Wilfin Beck, Lake District	800 – 18,000	Elliott (unpublished)
R. Yarty, East Devon	1,025 – 29,868	Bailey (1966)
Walla Brook, Dartmoor	1,500 – 32,000	Elliott (1967)
R. Duddon, Lake District	35,000 – 200,000	Elliott & Minshall (1968)
Swedish River, Lapland	2,629,500 – 9,048,000	Ulfstrand (1968)
Speed River, Canada	20,380 – 366,417	Bishop & Hynes (1969)
R. Leven, Lake District	46,060 – 403,358	Elliott & Corlett (1972)
R. Wye, Mid Wales	27,000 – 1,190,000	This study
R. Elan, Mid Wales	8,000 – 105,000	This study

Table 11

Estimates of Copepoda and cladocera drifting from Caban Coch and Windermere

Lake	Date	Discharge (cumec)	Total numbers/24h
Windermere	July	8.7	126,746 x 10^4
Windermere	July	5.1	7,423 x 10^4
Caban Coch	October	1.5	93,528 x 10^4

Figure 1

Invertebrate sampling sites in the Wye Catchment Area.

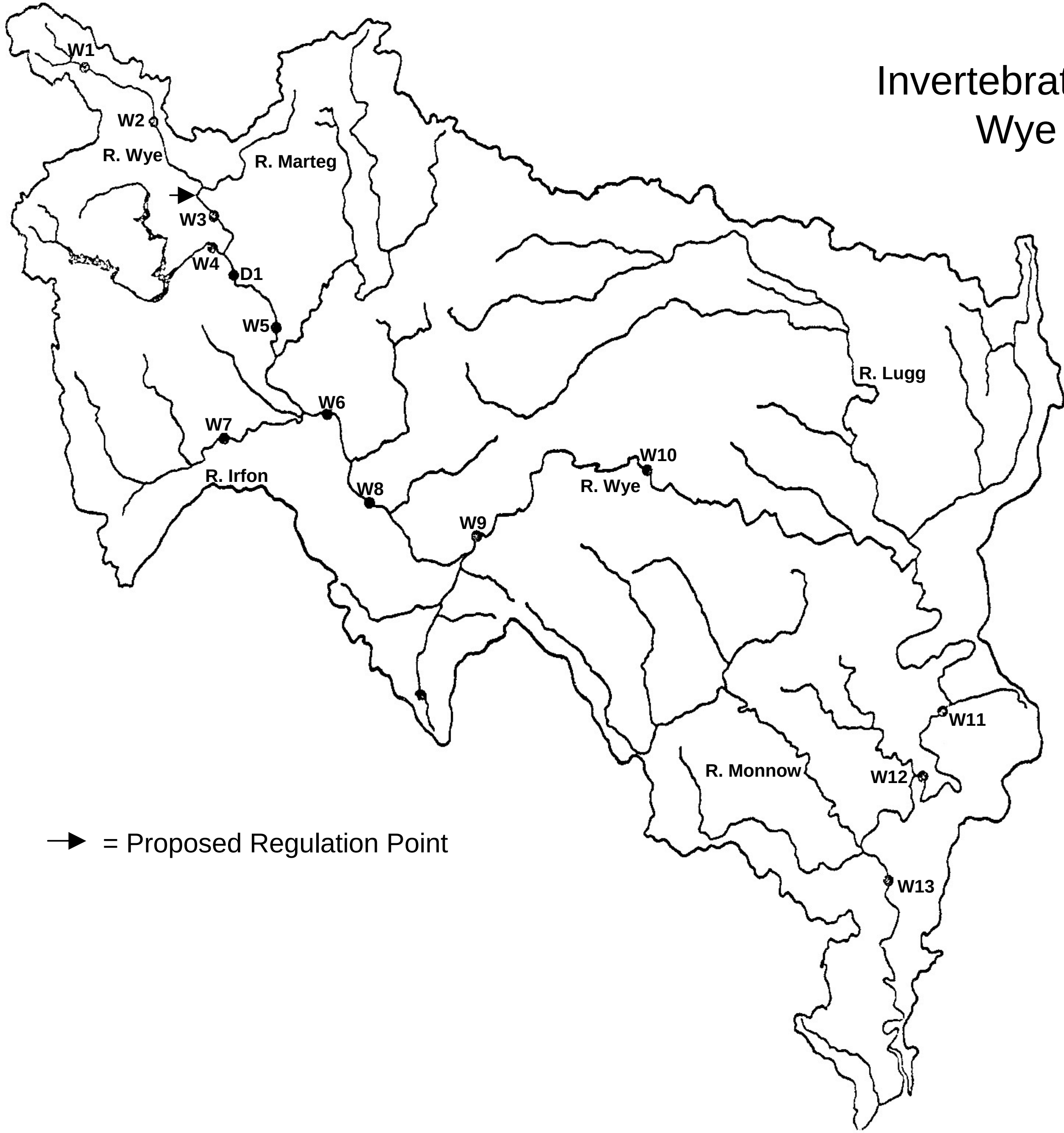


Figure 2

No. of taxa and total invertebrate densities, R. Wye catchment, 1975

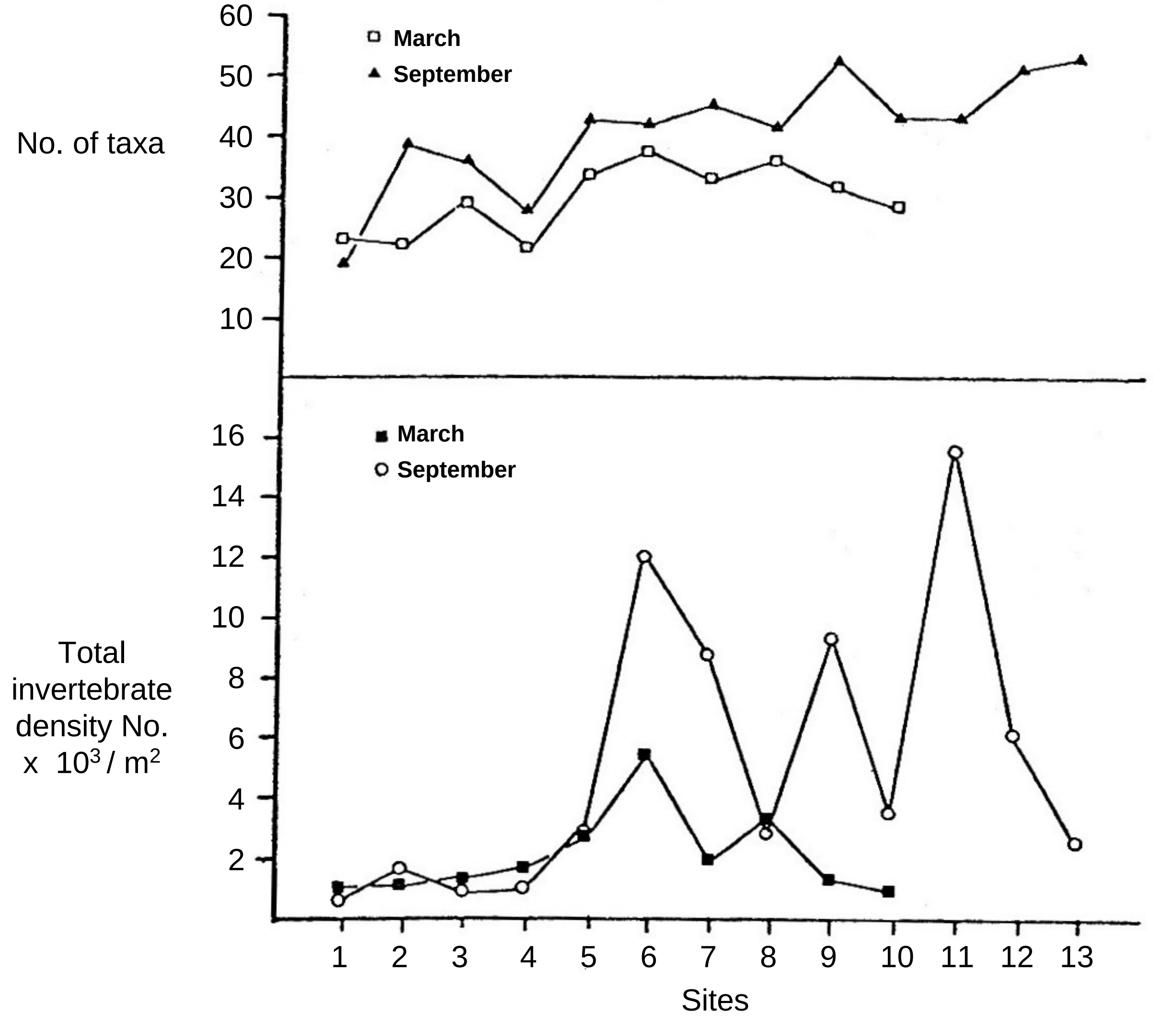


Figure 3

Average linkage cluster of Jaccard Index. R. Wye a) March b) September

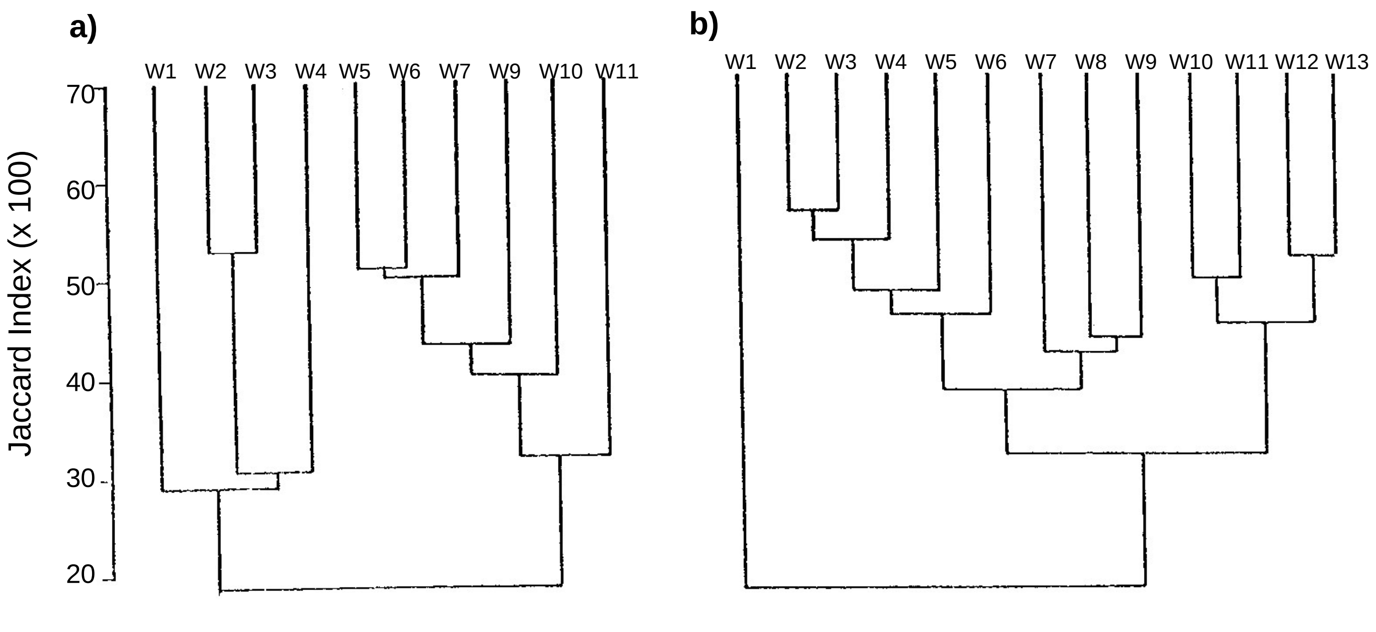


Figure 4

Distribution of Major Taxa (except Chironomidae) in the R. Wye

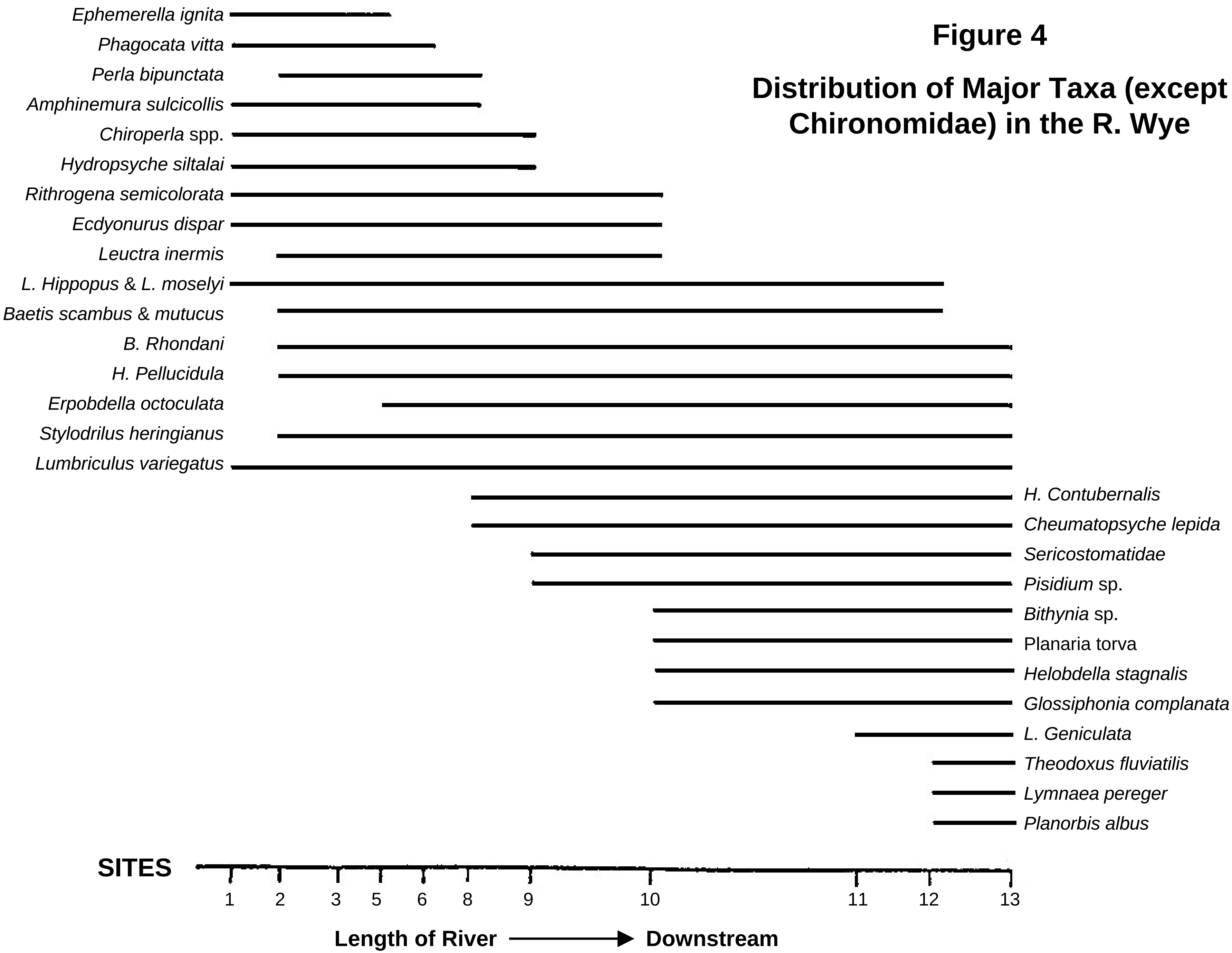


Figure 5

Changes in mean total invertebrate density at W2 & W3

arithmetic, mean, confidence limits calculated from transformed counts log x

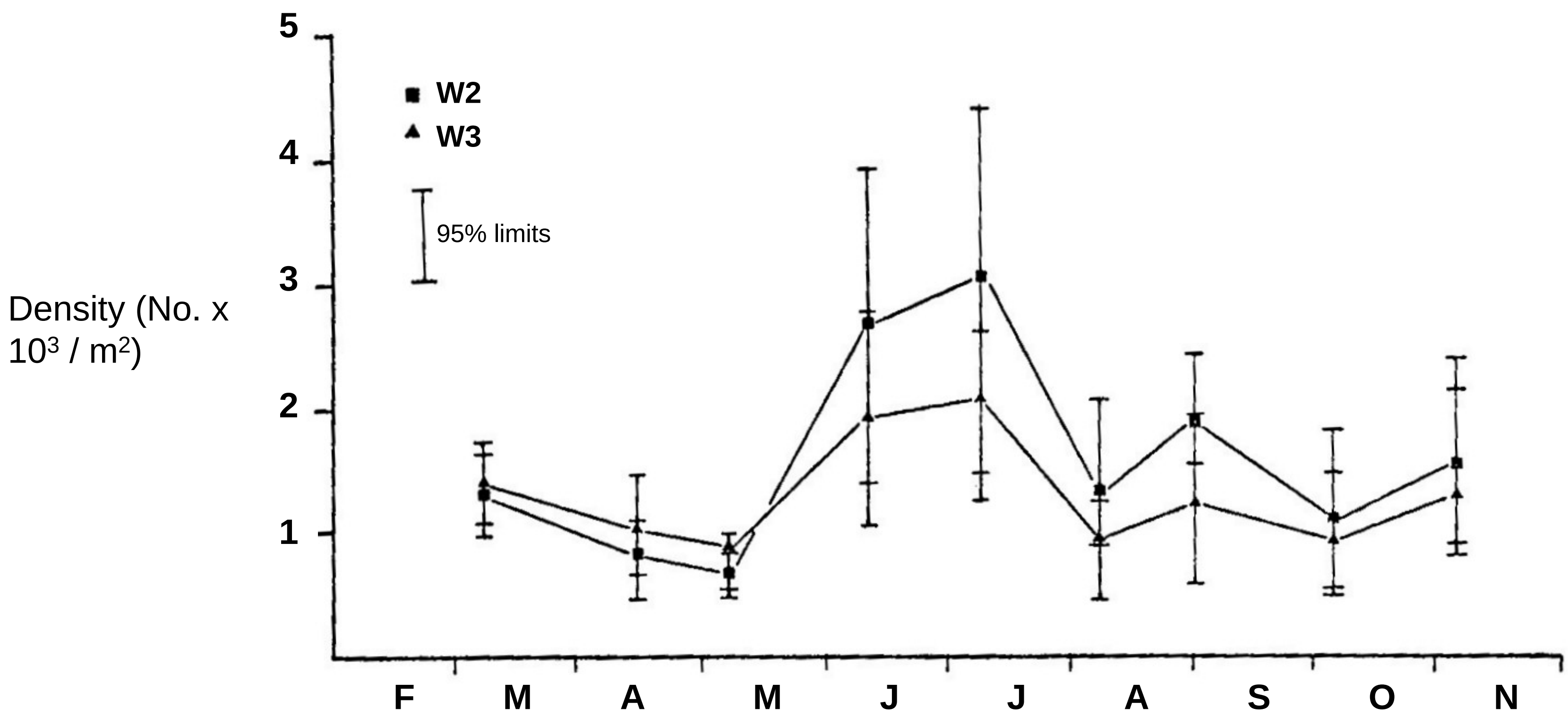
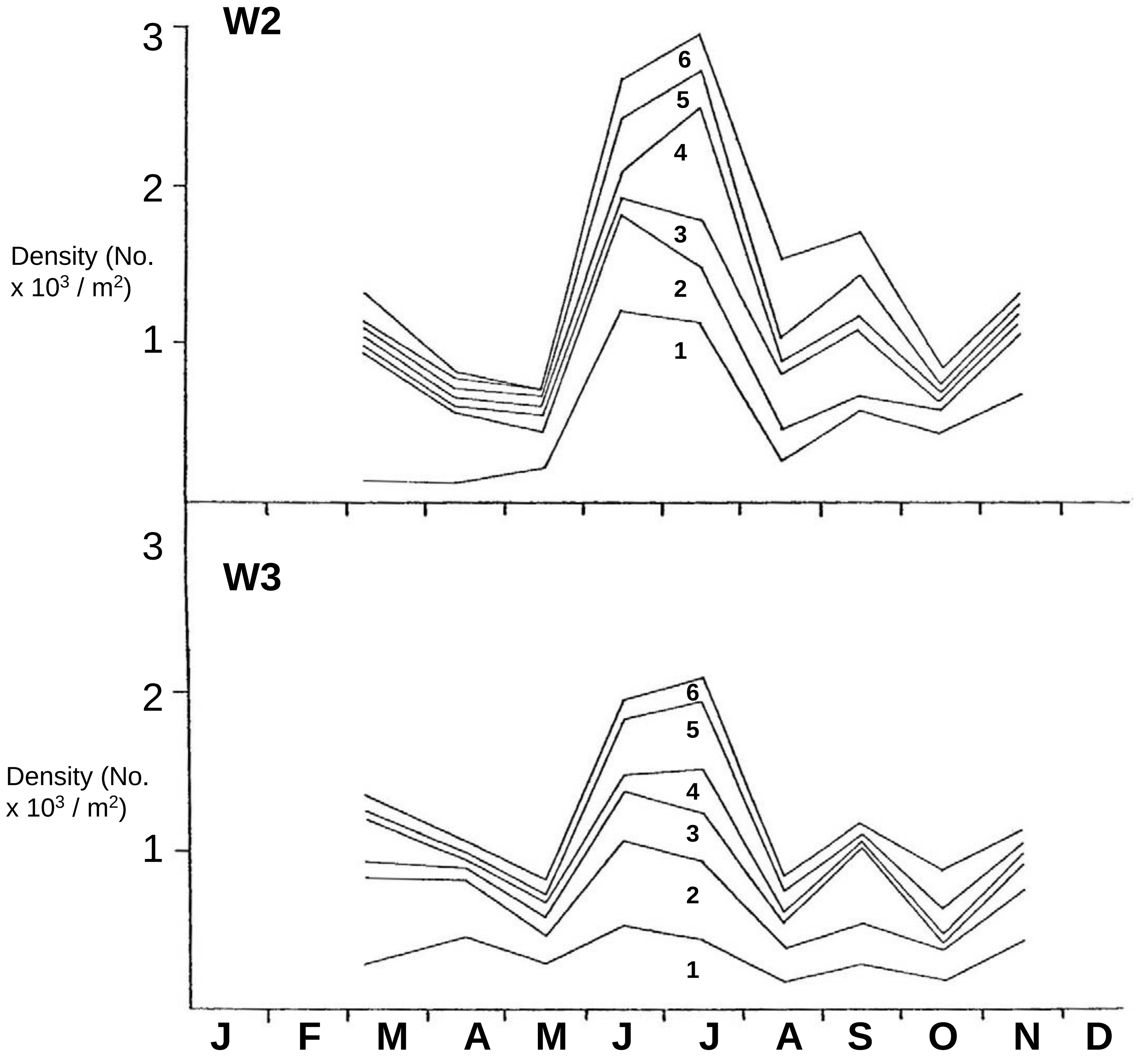


Figure 6

Changes in density of major groups at W2 & W3



1 = Ephemeroptera

2 = Plecoptera

3 = Trichoptera

4 = Coleptera

5 = Chironomidae

6 = Other invertebrates

Figure 7

Distribution of taxa not collected in routine samples (RS)

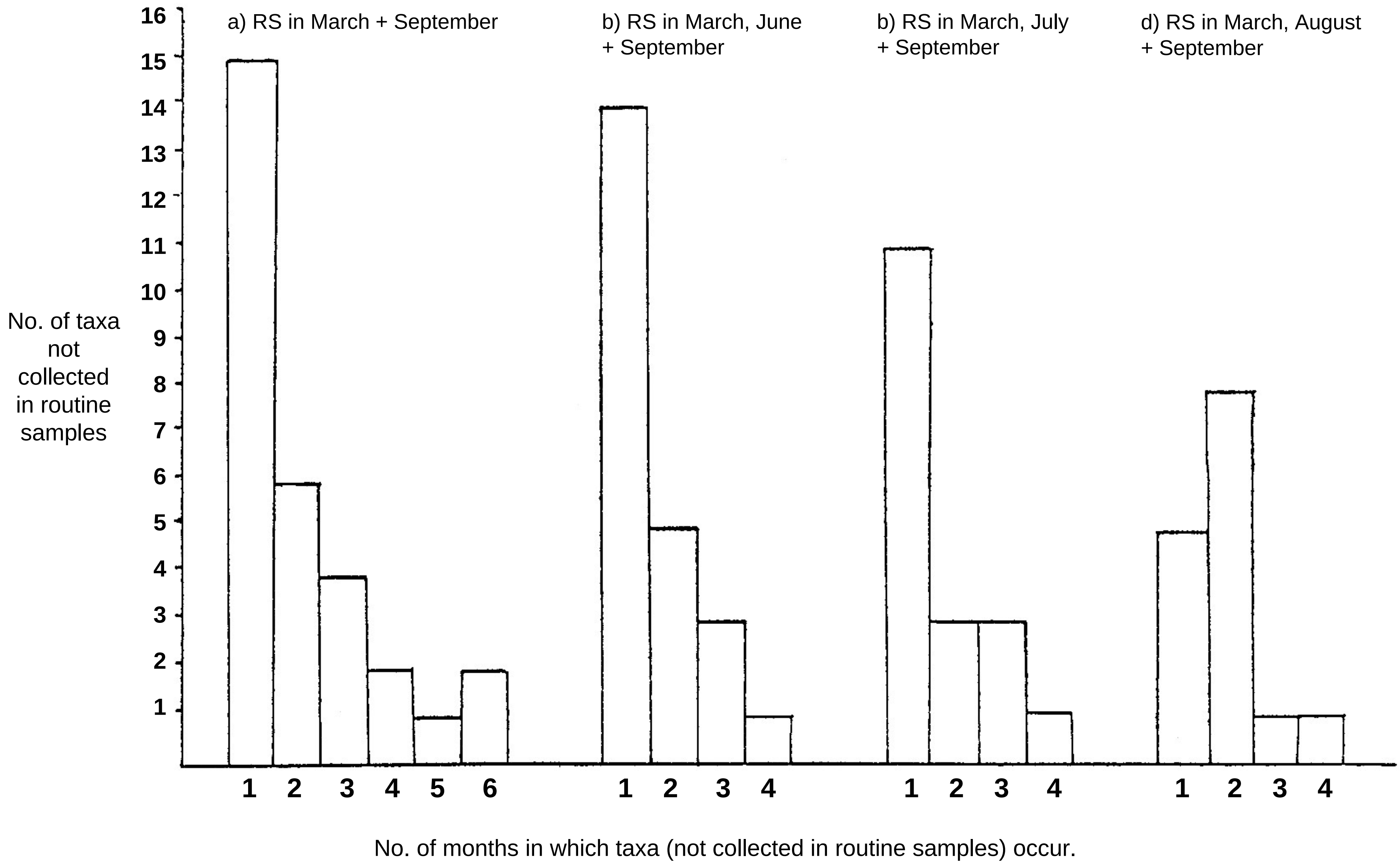


Figure 8

Changes in invertebrate drift density 5-6 March 1975

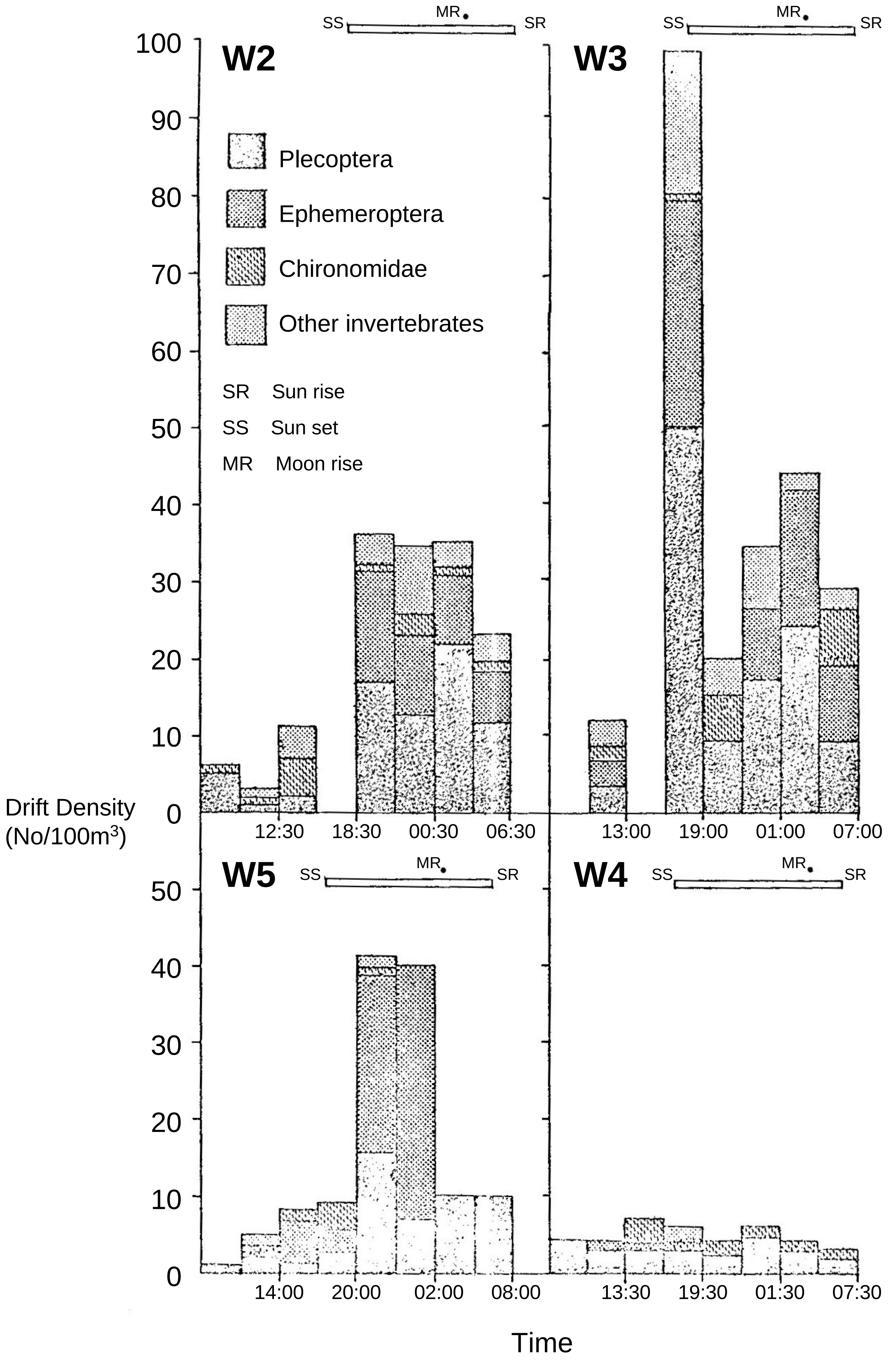
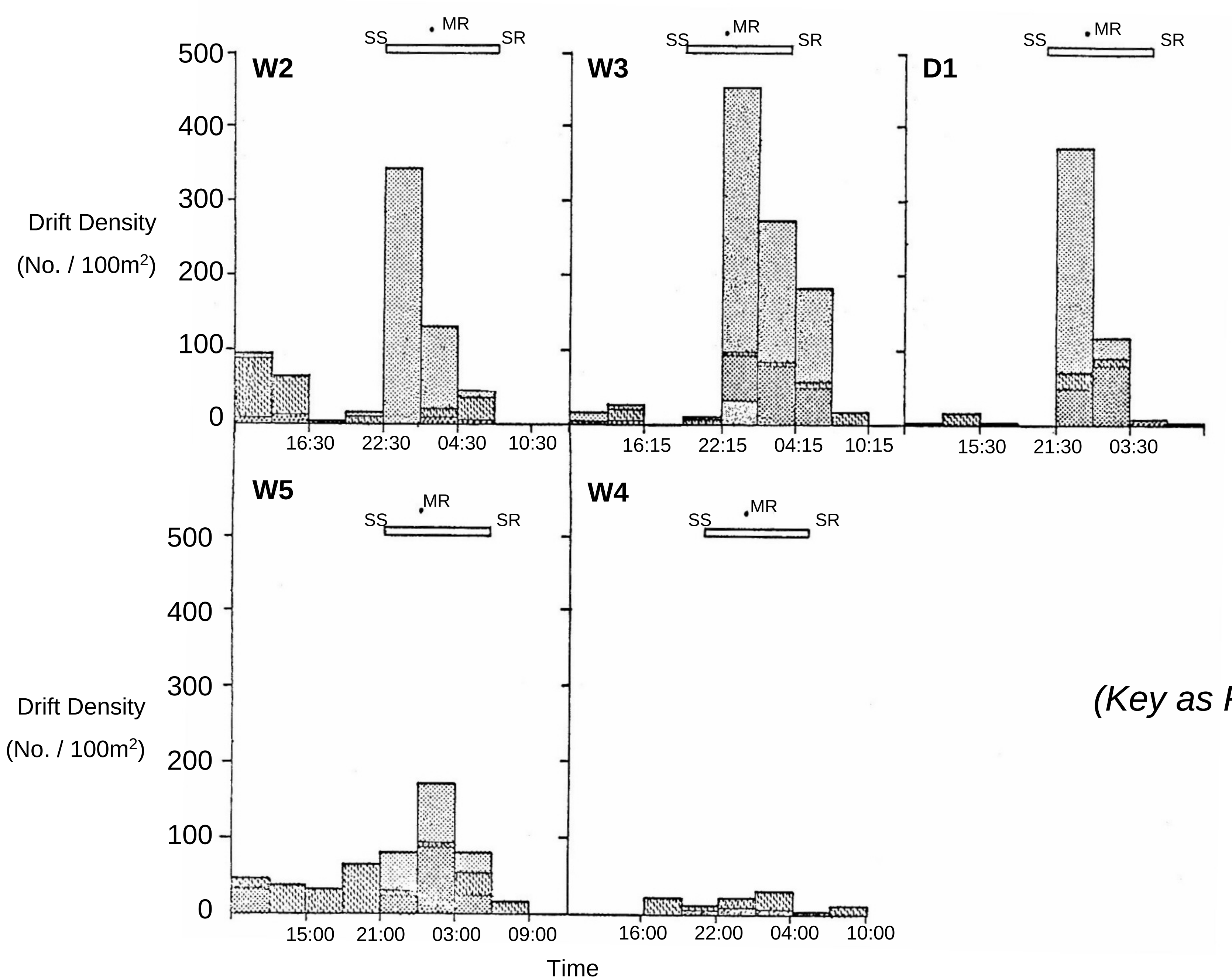


Figure 9 – Changes in invertebrate drift density 30-31 May 1975



(Key as Fig. 8)

Figure 10 – Changes in invertebrate drift density 10-11 July 1975

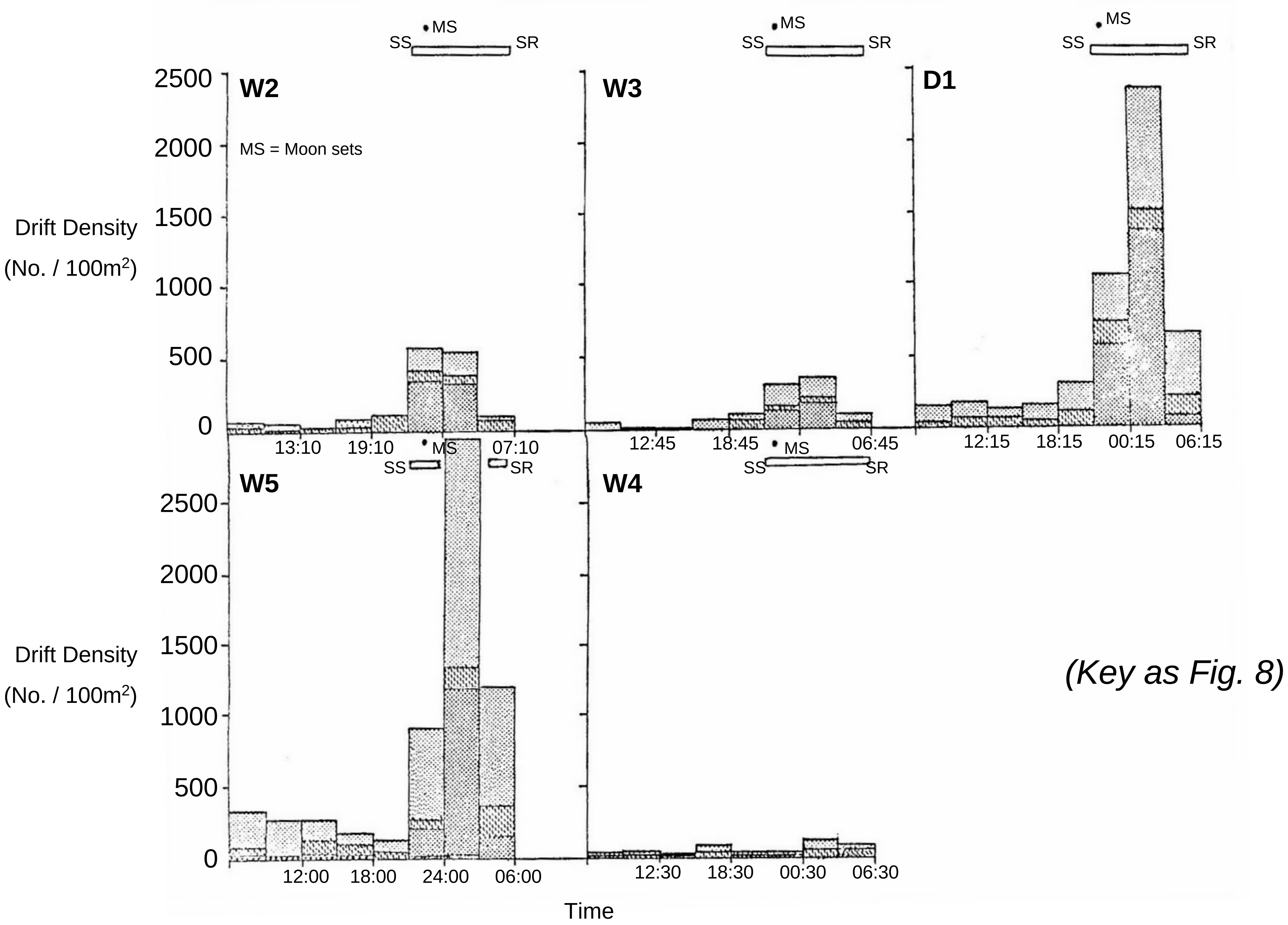


Figure 11a

Changes in invertebrate drift density 30 May – 1 June 1975 at W3

(Key as Fig. 8)

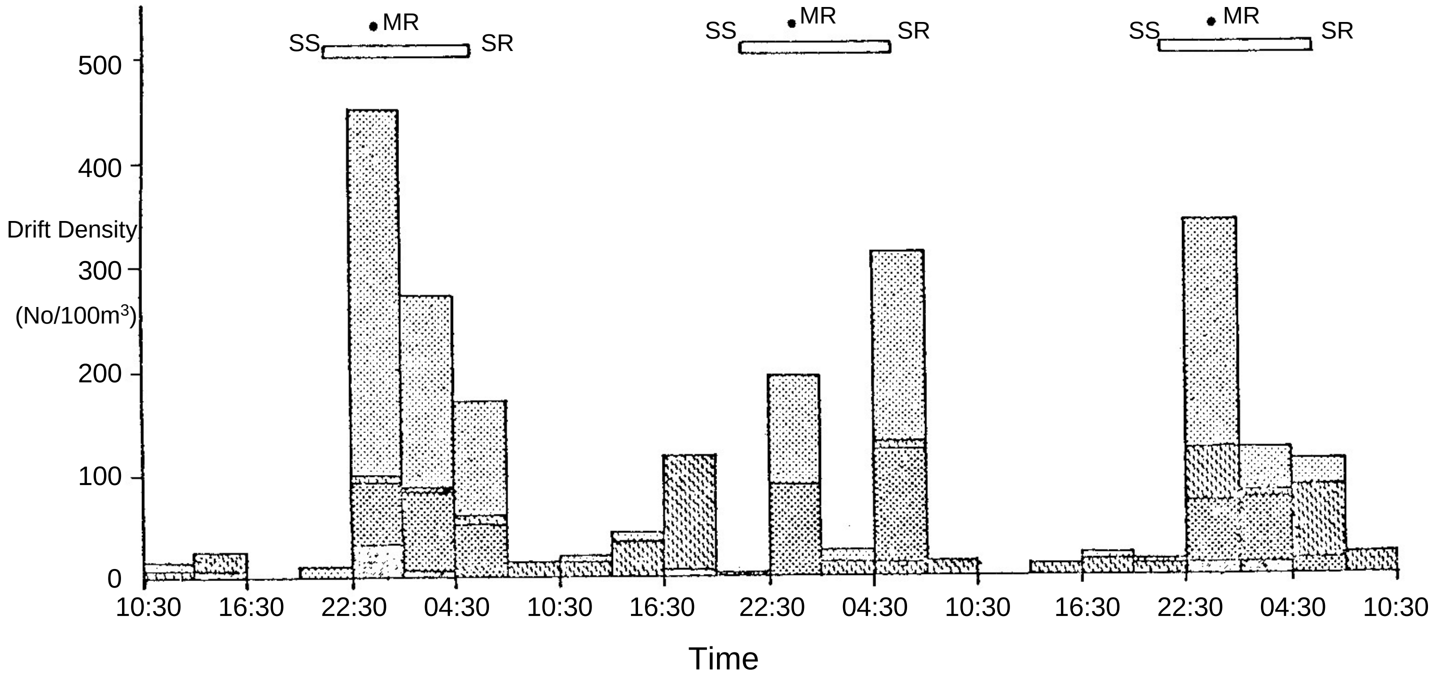


Figure 11b

Changes in invertebrate drift density 30 May – 1 June 1975 at W5

(Key as Fig. 8)

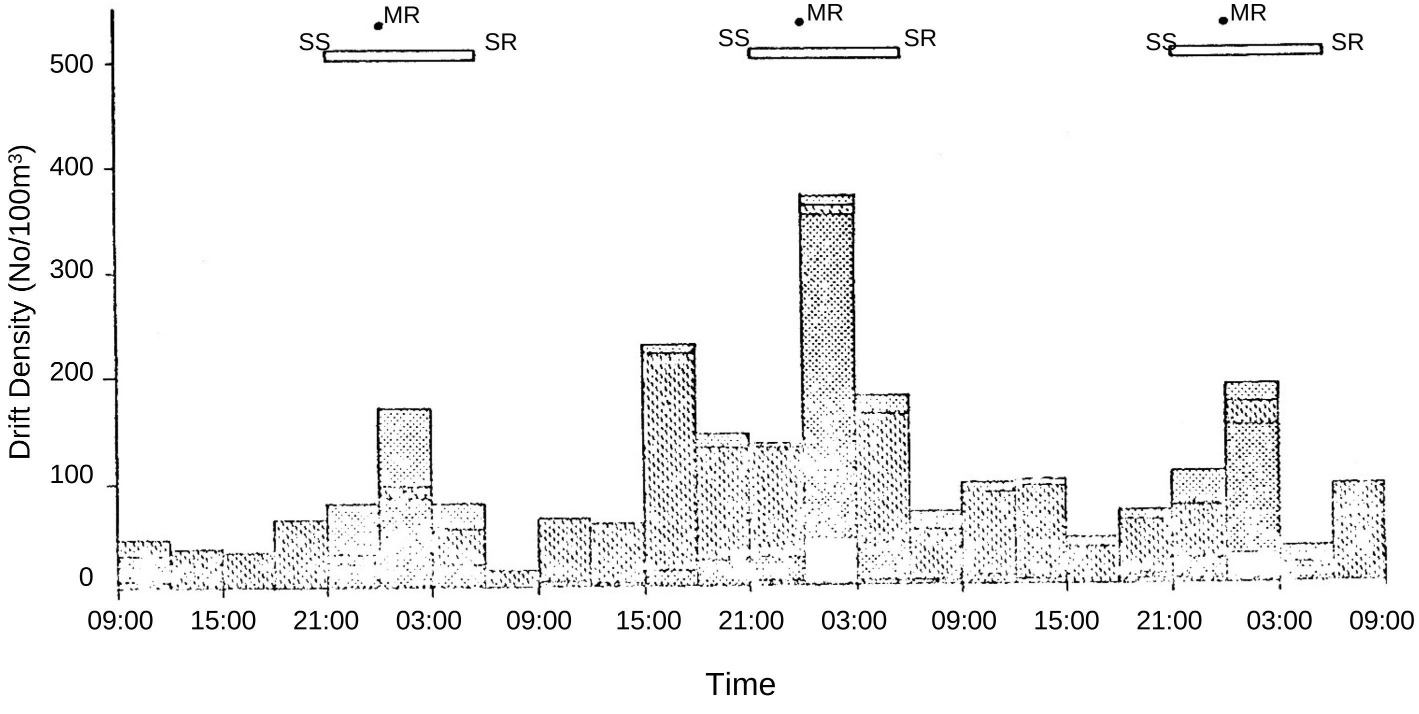


Figure 12

Drift of *Ceriodaphnia* from Caban Coch, 11th October 1975